Attachment H

Proposal # 2001-B200 (Office Use Only)

PSP Cover Sheet (Attach to the front of each proposal)

Proposal Title: Development of an Effective Management Strategy for the Introduced Chinese Mitten Crab, Eriocheir sinensis: Investigations of Recruitment Dynamics
Applicant Name: The Regents of the University of California
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Amount of funding requested: $ 229,963
Some entities charge different costs dependent on the source of the funds. If it is different for state or federal funds list below.
State cost. _____ Federal cost _____

Cost share partners? ___ **Yes** _X_ **No**
Identify partners and amount contributed by each _____

Indicate the Topic for which you are applying (check only one box).

- ☐ Natural Flow Regimes
- ☒ Nonnative Invasive Species
- ☐ Channel Dynamics/Sediment Transport
- ☐ Flood Management
- ☐ Shallow Water Tidal/ Marsh Habitat
- ☐ contaminants
- ☐ Beyond the Riparian Corridor
- ☐ Local Watershed Stewardship
- ☐ Environmental Education
- ☐ Special Status Species Surveys and Studies
- ☐ Fishery Monitoring, Assessment and Research
- ☐ Fish Screens

What county or counties is the project located in? Alameda, Contra Costa, Marin, San Mateo, Santa Clara, Solano, Sonoma

What CALFED ecozone is the project located in? See attached list and indicate number. Be as specific as possible 2

Indicate the type of applicant (check only one box):

- ☐ State agency
- ☐ Public/Non-profit joint venture
- ☐ Local government/district
- ☒ University
- ☐ Other: _____
- ☐ Federal agency
- ☐ Non-profit
- ☐ Tribes
- ☐ Private party

Indicate the primary species which the proposal addresses (check all that apply):

- ☐ San Joaquin and East-side Delta tributaries fall-run chinook salmon
- ☐ Winter-run chinook salmon
- ☐ Spring-run chinook salmon
- ☐ Late-fall run chinook salmon
- ☐ Fall-run chinook salmon
- ☐ Delta smelt
- ☐ Longfin smelt
- ☐ Splittail
- ☐ Steelhead trout
- ☐ Green sturgeon
- ☐ Striped bass
- ☐ White Sturgeon
- ☐ All chinook species
- ☐ Waterfowl and Shorebirds
- ☐ All anadromous salmonids
- ☐ Migratory birds
- ☐ American shad
- ☐ Other listed T/E species: _____

Indicate the type of project (check only one box):

- ☒ Research/Monitoring
- ☐ Watershed Planning
- ☐ Pilot/Demo Project
- ☐ Education
- ☐ Full-scale Implementation

Is this a next-phase of an ongoing project? Yes ___ No X

Have you received funding from CALFED before? Yes ___ No X

If yes, list project title and CALFED number _____

Have you received funding from CVPIA before? Yes ___ No X

If yes, list CVPIA program providing funding, project title and CVPIA number (if applicable):

_____

By signing below, the applicant declares the following:

- The truthfulness of all representations in their proposal;
- The individual signing the form is entitled to submit the application on behalf of the applicant (if the applicant is an entity or organization); and
- The person submitting the application has read and understood the conflict of interest and confidentiality discussion in the PSP (Section 2.4) and waives any and all rights to privacy and confidentiality of the proposal on behalf of the applicant, to the extent as provided in the Section.

The Regents of the University of California

Printed name of applicant

original signed by

Signature of applicant **Michiko Taniguchi**

Sponsored Projects *Officer*

EXECUTIVE SUMMARY

Project Title: Development of an effective management strategy for the introduced Chinese mitten crab, *Eriocheir sinensis:* Investigations of recruitment dynamics.

Amount requested: $229,963

Applicant Name: Carrie Culver and Mark Walter, Marine Science Institute, University of California, Santa Barbara, CA 93106. Tel: (805) 893-8083, Fax: (805) 893-8062, Email: c_culver@lifesci.ucsb.edu and walter@lifesci.ucsb.edu.

Collaborators: Tanya Veldhuizen, Dept. of Water Resources

Project Description:

The Chinese mitten crab, *Eriocheir sinensis,* is one of the most successful invaders of the San Francisco Estuary, with population estimates in the millions. It is formally recognized as a harmful aquatic species by the National Aquatic Nuisance Species Task Force. **A** catadromous species, this pest currently utilizes brackish habitats in both the North and South bays, and freshwater habitats encompassing the extensive tributaries of the entire Sacramento-San Joaquin Delta, Suisun Bay, San Pablo Bay and tributaries of the South Bay on both the west and east shorelines from the San Mateo Bridge south. Its presence has resulted in substantial economic impacts, particularly to the federal and state water diversion plants. The crabs have also impacted commercial and recreational fishermen and power plants. Further, many major ecological impacts are anticipated (and are the focus of ongoing research) given that it occupies freshwater habitats that have never supported such an organism and based on the impacts experienced in Europe. Thus, while management of this species is needed, development of effective and efficient theoretically-based management strategies are hindered by the lack of biological information for the San Francisco Bay (SFB) mitten crab population.

We propose to conduct a targeted research project in the lower San Francisco Estuary investigating factors affecting recruitment dynamics of *Eriocheir sinensis.* Our objectives are to: 1) identify larval settlement patterns, specifically peak settlement times and physical factors (i.e., salinity, temperature, water flow) associated with settlement; 2) assess reproductive events of the mitten crab population by locating brooding grounds, peak brooding periods and the number of broods produced by individual females and 3) identify age at maturity, and thus the number of year classes that constitute the mitten crab population. Our hypotheses for each objective include: 1a) Larval settlement is greatest in late spring and early summer, 1b) Peak settlement coincides with low water flow periods, 2a) Females aggregate in specific brooding areas, 2b) Certain months represent peak brooding periods, 2c) Females produce more than one brood of eggs during the reproductive season and 3a) Crabs mature at different ages in the North and South bays. The information necessary to test these hypotheses will be collected using standard larval settlement collectors, trawl surveys and laboratory studies. By understanding the recruitment issues outlined in our objectives we will gain information on when, where and how long mechanical (removal)-based management efforts would be required. Once this information is known, an effective and efficient theoretically-based removal strategy can be developed for this non-native invasive species. Subsequent implementation of management efforts should not only decrease economic and ecological impacts in the SFB area (ERP Goal 5/NIS Goal 111), but it would also reduce the potential spread of this pest to others areas in California and North America (NIS Goal II).

PROJECT DESCRIPTION

Problem Addressed by Project

The Chinese mitten crab, ***Eriocheir*** *sinensis*, is distributed throughout the San Francisco Bay (SFB) and surrounding freshwater delta, with population estimates in the millions. A catadromous species, adults breed in the estuary and juvenile crabs migrate to freshwater to mature. Substantial economic losses due to the presence of the mitten crab have already occurred in California (reviewed by Veldhuizen & Stanish 1999). In particular, fish recovery operations at federal and state water diversion plants have been severely hindered by the crabs. Approximately $500,000 was spent by the United States Bureau of Reclamation and the California Department of Water Resources, combined, to address mitten crab impacts to salvage operations. Further, the reliability of water deliveries to the state water contractors has been in question as the influx of mitten crabs overlaps with the outmigration (and subsequent entrainment) of juvenile winter-run chinook salmon. Cooling system operations at two power plants in the North Bay have also been impacted by the crabs. In addition to impacting facility operations, California commercial and recreational fishermen have experienced reduced catches, reduced quality of their target organisms, increased gear damage and/or increased bait loss due to the mitten crabs. Ecological impacts have also undoubtedly occurred, although studies of such impacts have only recently been funded. The introduction of the Chinese mitten crab in Europe resulted in substantial ecological changes through predation, competition and habitat destruction (due to burrowing activity). Extinction of at least one species and dramatic declines of many other species (both finfish and shellfish) have been attributed to the presence of mitten crabs in Germany (Gollasch 1999). In California such ecological changes are also likely, given the great abundance of the mitten crab. Furthermore, because no native crabs have ever existed in the sensitive freshwater habitats of the San Francisco Estuary, many native California species are undoubtedly at high risk as they lack evolved defenses against such a predator. Given the considerable economic and ecological impacts of this pest (both realized and anticipated), the National Aquatic Nuisance Species Task Force has listed the Chinese mitten crab as a harmful non-indigenous aquatic species, for which management strategies (eradication and/or control) need to be developed. However, as identified in the draft National Mitten Crab Management Plan, additional biological information is needed before management strategies can be developed.

Management of mitten crab populations in other countries has been limited (Veldhuizen & Stanish 1999; Gollasch 1999). The most extensive efforts involved trapping of upstream migrating juvenile crabs. However, such migrations have been documented only once in the SFB mitten crab population making this control measure infeasible. Further, trapping of resident juveniles has proven difficult as they are not completely carnivorous at this stage and often inhabit burrows along stream banks. Most importantly, implementation of management measures that manipulate juveniles seem highly implausible as these crabs are most spatially widespread during this stage. Such measures would have to be implemented on an immense spatial scale, encompassing the extensive tributaries of the entire Sacramento-San Joaquin Delta, Suisun Bay, San Pablo Bay and South SFB (rivers and tributaries on both the west and east shorelines from the San Mateo Bridge south). In comparison, adult mitten crabs migrate to SFB to breed, potentially providing an opportunity for mass removal on a much smaller spatial scale. Mechanical (removal)-based management efforts would undoubtedly reduce the mitten crab population significantly over time by reducing larval production and release in SFB. Such declines in populations have been documented for commercially and recreationally harvested species whose reproductive events were not adequately protected. However, further biological information is needed before we can develop such a management strategy for the Chinese mitten crab.

In accordance with Goal #5 of the Ecosystem Restoration Program (Non-native invasive species), we seek to better understand factors affecting recruitment dynamics of ***Eriocheir*** *sinensis* so as to develop a theoretically-based removal strategy for this invasive species. Our objectives are three-fold: 1) to identify larval settlement patterns, specifically peak settlement

times and physical factors (i.e., salinity, temperature, water flow) associated with settlement; **2)** to assess reproductive events of the mitten crab population by locating brooding grounds, peak brooding periods and the number of broods produced by individual females and 3) to identify age at maturity, and thus the number of year classes that constitute the mitten crab population. Development of effective and efficient management strategies (of any type) will be hindered without the information outlined in these objectives.

Conceptual Model

This project serves as a Stage 4 targeted research project as slated on page 15 of the CALFED 2001 Proposal Solicitation Package (PSP) of the Ecosystem Restoration Program (ERP). That is, we are undertaking targeted research to provide necessary knowledge for guiding management activities. Our conceptual model (Figure 1) resembles that of a fisheries management model. We propose to evaluate factors influencing recruitment dynamics of the mitten crab, including larval settlement patterns, reproductive events and age at maturity. Unlike fisheries management models that look at population dynamics as a whole, we are focusing on recruitment issues. This is in part due to the idea that adults may be more readily manipulated, which would impact larval production and thus recruitment. In addition, recruitment issues are likely the most important regulatory factors of the mitten crab population. This belief is based on the fact that no post-recruitment factors (e.g., predators, competitors) are apparently effective at controlling the current mitten crab population. Further, strong year classes have apparently coincided with conditions (e.g., low precipitation years) believed to promote larval survivorship and settlement, and thus recruitment. Similarly, weak year classes have apparently coincided with conditions (e.g., high precipitation years) believed to decrease larval survivorship and settlement. Importantly, unlike fisheries management, we seek to understand vulnerabilities in the population so that such factors could be *exploited* to reduce the population, thereby minimizing/eliminating negative impacts of the mitten crab. By understanding the recruitment issues outlined in our objectives we will gain information on when, where and how long management efforts would be required. Once this information is known, an effective and efficient theoretically-based removal strategy can be developed for the non-native invasive Chinese mitten crab.

Larval settlement patterns: We propose to first assess larval settlement patterns by determining peak settlement periods and the role of physical factors in larval settlement. Our hypotheses include: 1a) Settlement is greatest in late spring and early summer and 1b) Peak settlement coincides with low water flow periods. These previously suggested hypotheses (Anger 1991; Attrill and Thomas 1996) are based on studies of salinity and temperature tolerances of mitten crab larvae and the documentation of marked increases in mitten crabs in several countries following the drought years of the 1980s and 1990s. As we believe recruitment events represent the most important regulatory factor of the SFB mitten crab population, it is essential that we not only identify peak settlement periods, but also physical factors associated with settlement. This information will help direct management efforts by identifying reproductive events (periods) most responsible for peak settlement. Removal efforts could be directed to these reproductive events. In addition, determining whether settlement is correlated with physical parameters (e.g., water flow, temperature, salinity) will help predict the need for management efforts in any given year (i.e., drought years). Barring implementation of management efforts, this information would at least provide a means for predicting years of strong year classes and thus years of substantial impacts to water diversion plants and commercial and recreational fishermen, provided age at maturity (see below) is determined.

Reproductive Events: In addition to larval settlement, we will assess reproductive events of the SFB mitten crab population. Specifically, we will determine whether particular areas of SFB represent brooding grounds for the mitten crab, when peak brooding occurs, and the number of broods a female produces during the reproductive season. Our hypotheses are as follows: 2a) Females aggregate in specific brooding areas, 2b) Certain months represent peak brooding periods, and 2c) Females produce more than one brood of eggs during the reproductive season. Identifying the existence of brooding grounds will determine whether mass crab removals can be

targeted at particular sites, thereby reducing the spatial scale over which management efforts are implemented. Removal of females from these regions prior to spawning would significantly reduce the number of larvae and thus new recruits, thereby decreasing the mitten crab population. Although systematic surveys to identify such sites in SFB have not been conducted, several groups trawling in SFB (e.g., commercial shrimp trawlers, the Marine Science Inst. of Redwood City, CDFG) have reported large catches of ovigerous (egg bearing) females in certain locations. In addition, given the salinity requirements of the deposited and developing eggs (≥ 20 ppt) (Ingle 1986; Anger 1991) brooding sites likely exist in association with salinity regimes. Thus, we will conduct systematic trawl surveys along salinity gradients (and thus water depth) to locate potential brooding areas.

In conjunction with identifying brooding sites, we will determine peak brooding periods in SFB. The effectiveness of mass adult crab removals could potentially be maximized by not only exploiting particular areas containing brooding females, but by concentrating efforts during certain months within the reproductive season when the majority of females are brooding. Ovigerous females in SFB occur from November to May (Veldhuizen & Hieb 1998). Peak fecundity (when most crabs have eggs) is unknown for South Bay crabs, but apparently occurs in February in the North Bay (K. Hieb personal communication). However, this evaluation of peak fecundity did not take into consideration brood size. We have seen variable sized broods, including extremely large broods where the abdominal flap is unable to close. As these large broods contribute substantially more larvae to the population, removal efforts would likely be most effective prior to spawning of these broods. This may differ from overall peak fecundity as it could be that more crabs have broods later in the season, but such broods are small in size. Thus, we will factor brood size into our evaluation of peak brooding times.

We will also examine whether variable brood size is associated with production of multiple broods by an individual female crab. It is presently unknown whether SFB crabs reproduce more than once during the reproductive season. The Japanese mitten crab (*Eriocheir japonica*), which may be a phenotype of the Chinese mitten crab and not a separate species (Li et al. 1993), reproduces up to three times with brood size decreasing with successive broods (Kobayashi 1999). If multiple broods are produced, removal of crabs would be most effective early in the season to eliminate continued contribution to the population. If females produce a single brood, removals would be most effective during the peak brooding period.

***Number of** populations:* No tasks are proposed for this element of the conceptual model due to the availability of information regarding this issue and the inherent problems with testing our hypotheses. However, we include a discussion here because of its importance to understanding recruitment dynamics.

Identifying whether North Bay and South Bay adult crabs, and/or the larvae they produce, intermix between the two regions is critical for determining where management efforts will need to be concentrated. If distinct (closed) populations exist, management strategies could be locally implemented and tailored to a specific region. In contrast, if one large intermixing (open) population exists, management schemes will have to consider recruitment dynamics on a much larger spatial scale. Without understanding the amount of adult or larval exchange between the two regions, much time and effort could be wasted as management efforts would be blindly implemented. For example, if adults/larvae from both regions intermix equally, simultaneous reduction of crabs in both the North and South bays would be needed to decrease the SFB crab population. Similarly, if adults/larvae from both regions intermix, but in different proportions, efforts concentrated in the North Bay could be ineffective at reducing the SFB mitten crab population if South Bay crabs were the primary source of larvae for the entire bay. In this case, management efforts would need to be implemented in the south, not the north. In contrast, if adults/larvae from the two regions do not intermix, management efforts could be conducted separately without jeopardizing the success of efforts in either region.

We believe that adults from the two regions do not intermix, but that larvae produced in the north may, under certain conditions, supplement the South Bay crab population, but not vice versa. Our belief is based on catch information of adults in SFB and hydrodynamic patterns of

SFB. Monthly CDFG trawls indicate that few mitten crabs occur in central SFB, north of the San Mateo Bridge and south of San Pablo Bay (K. Hieb, personal communication). This large gap in the distribution indicates adults from the two regions remain isolated from one another. We will confirm the existence of this distribution gap during our trawling activities outlined in Task 2 (Reproductive events). While the adults may stay in one region, the planktonic larvae could intermix via water circulation. However, hydrodynamic studies of SFB illustrate that little, if any, larvae produced in the South Bay would likely be transported to the North Bay as there is very minimal water exchange in this direction (Conomos 1979). In contrast, larvae produced in the North Bay could be transported into the South Bay, but *only* during years of high freshwater input. In fact, such was indirectly documented for the introduced Asian clam, *Potarnocorbula amurensis* (Thompson 1999). Our larval settlement studies may also provide supporting evidence of this hypothesis, depending on weather conditions during our project. This information will be incorporated into the development of our removal-based management strategy.

***Age** at maturity*: Lastly, we propose to determine the age at maturity of crabs from the North and South bays. Maturation of Chinese mitten crabs occurs at 1 to 5 years of age, depending on environmental factors, with those in SFB thought to mature in 2 to 3 years (Veldhuizen & Stanish 1999). Size at maturity is markedly different between the North and South bays, with South Bay crabs maturing at significantly smaller sizes (Culver & Walter, unpublished data; CDFG, unpublished data). It is unknown whether the size difference between the two areas is due to earlier maturation of South Bay crabs, or larger molt increments or shorter molt intervals of North Bay crabs. Crabs from different regions of China mature at different ages, with crabs from one area maturing in one year and at relatively small sizes and crabs from another area maturing later and at larger sizes (Veldhuizen 2000). Such differences in age at maturity may explain the difference in size at maturity between the North Bay and South Bay crabs. Thus, we hypothesize that crabs mature at different ages in the North and South bays. Determining age at maturity is important for understanding how many year classes constitute the mitten crab population, and thus how long concentrated management efforts would be needed to reduce the mitten crab population. We propose to investigate molt increments and intervals of mitten crabs collected from the North and South bays in the lab. Hiatt Growth Diagrams will be produced, allowing interpretation of the age at maturity among crabs from each region.

PROPOSED SCOPE **OF WORK**

Location **of** the Project

This project requires collection of adult mitten crabs throughout SFB, primarily in San Pablo Bay, Suisun Bay and the South Bay, south of the San Mateo Bridge. Juvenile crabs will be obtained from various creeks and tributaries of the SFB watershed by other mitten crab researchers working on this stage of the crab. Larval settlement collectors will be placed in the bay near the Petaluma River, Suisun Slough, and Chipps Island in the North Bay and Alameda Creek, Guadalupe Slough and Permanente Creek in the South Bay. These areas are represented by ecozone 2 and the following counties: Solano, Sonoma, Marin, Santa Clara, Contra Costa, Alameda and San Mateo.

Approach

Larval settlement: To determine peak larval (megalopae) settlement periods and factors associated with peak settlement, we will deploy passive larval collectors at six sites in SFB. Passive collectors, which provide an artificial substrate for settling organisms, are commonly used to determine settlement rates of many marine and estuarine species (Witham et al. 1968; Serfling & Ford 1975; Little and Milano 1980; Beninger et al. 1986; Ebert et al. 1991; Boylan & Wenner 1993; Wing et al. 1995). Four sets of collectors will be deployed at each site. Each set of collectors will consist of 8 dish scrub pads (Tuffy®) attached in 2 groups of 4 to a weighted

polypropylene line with a float. One group will be approximately 1m from the bottom. The other group will be approximately 1m below mean low water. Collectors will be deployed at sites associated with areas of high crab abundance, including the Petaluma River, Suisun Slough, and Chipps Island (adjacent to the channel providing larvae to both the Sacamento and San Joaquin rivers) in the North Bay and Alameda Creek, Guadalupe Slough and Permanente Creek in the South Bay. Collectors will be replaced twice a month, at which time retrieved collectors will be washed in freshwater and the resulting material sorted for newly settled crabs. All crabs will be identified to species and enumerated. Physical data, including salinity, temperature and water flow, will also be collected at each site. Temperature loggers (Hobo®) will be deployed at the surface and bottom of one line at each site. Surface and bottom salinity and water flow will be recorded during retrieval of the larval collectors. Daily readings on salinity and water **flows** will be obtained from USGS and DWR hydrologic monitoring stations in areas close to the collectors. The association between physical factors and crab settlement will be analyzed using correlation statistics. These tasks will be conducted during the presumed period of larval settlement (January through July) for both Years 1 and 2.

Reproductive events: To identify brooding sites, we will conduct trawl surveys in ***6*** regions of SFB; Suisun Bay, Carquinez Strait, San Pablo Bay in the North Bay, between the San Mateo Bridge and Pt. Richmond in the Central Bay and between the San Mateo and Dumbarton bridges and south of the Dumbarton Bridge in the South Bay. With the exception of the Central Bay, these areas are known to contain high numbers of adult crabs, as witnessed by several groups trawling in SFB. Few crabs apparently occur in the Central Bay, as evidenced by CDFG and MSI/Redwood City trawl data, presumably because very few rivers flow into the region. However, we will confirm that a gap in distribution occurs in the Central Bay. Within each region, three 10 minute trawls will be made in the shallows, deep channels and at an intermediate depth, depending on the topography of the region. Physical factors (e.g., temperature, salinity, water depth, habitat type) will be recorded for each site and correlated with crab abundance and sex ratio. Collected crabs will be measured (carapace width) and sexed. All females will be examined for the presence of eggs, with brood size qualified (small, medium, large and extra large) based on the amount of space the eggs occupy in the abdomen. The presence/absence of eye spots will also be recorded to provide information on developmental stage of the eggs (eye spots indicate a late developmental stage where larvae will soon be released). Surveys will be conducted from December through January, the time adult crabs are generally most abundant in SFB.

To identify peak brooding periods, we will examine crabs collected by others trawling in SFB. The Marine Science Institute of Redwood City conducts daily trawls, and CDFG conducts monthly trawls. We are presently collaborating with both of these groups and will continue to do so. We are also currently discussing with CDFG ways of obtaining crabs from commercial fishermen (crabs can not be transported live by the fishermen, and normal methods for killing marine organisms (freshwater, ice) are not effective). Crabs will be measured (carapace width) and sexed. All females will be examined for the presence of eggs, with brood size qualified and the presence/absence of eye spots recorded. We will examine all crabs collected by these groups during the 2001/2002 breeding season (anticipated October – May).

To determine whether females can produce more than one brood, up to 50 gravid females from both the North and the South bays will be held in aquaria at the Marine Science Institute in Redwood City. Only females with extra large broods will be used, as presumably such broods represent the first brood released by the crab. Crabs will be checked daily for release of the initial brood and extrusion of an additional brood. If consecutive broods have not been extruded within two weeks after release of the initial brood (sufficient time for extrusion of an additional brood), male crabs will be added to half of the aquaria to determine whether additional mating events lead to extrusion of additional broods. Females will be examined for the presence of an additional brood for two weeks following placement of the males in the tanks. Broods are typically extruded within a day following successful mating. This task will be conducted from

December 2001 (when females contain extra large broods) through February 2002 (larvae are released approximately 2 months following extrusion).

Size ut maturity: Traditional absolute growth studies (molt increments and intervals) will be conducted to determine age at maturity of the SFB mitten crabs (reviewed in Mauchline 1976; Mauchline 1977; Hartnoll 1982). We will obtain monthly samples of North Bay and South Bay juvenile crabs (≥30) from mitten crab researchers working on this stage. During periods of known molting (as evidenced by the presence of exuvia in juvenile habitats), larger sample sizes will be obtained. Crabs will be maintained in flow through aquaria, with carapace width measured prior to placement in the aquaria. Molting events will be recorded and the carapace width remeasured 5 days after molting (thus allowing time for the exoskeleton to calcify). Crabs will be held through two successive molts to obtain data on molt intervals. Molt increments will be quantified from molting events occurring within the first two weeks of collection, as longer holding times can affect the molt increment. Hiatt growth diagrams (a stepwise growth graph) will be constructed for North Bay and South Bay crabs to assess age at maturity. This task will be conducted from April 2001 through March 2002.

Data storage/Products

We will develop a MS Access database for storing all data. This will be made available through the IEP mitten crab website (www.iep.ca.gov). Updates will be given at the quarterly IEP Chinese Mitten Crab Project Work Team meetings. In addition, articles will be submitted to the IEP Newsletter at the completion of each objective (3 articles total) and at the end of the project. Presentations will be given at the annual CALFED Science Conference in October of each year. In addition, findings will be submitted for publication in the international journal *Biological Invasions*. These papers/presentations will describe the potential for management of the Chinese mitten crab, in particular removal-based strategies.

Work Schedule

All tasks to be conducted during the course of this investigation are summarized in the milestone chart (Figure 2). In order to develop a removal-based management strategy for the Chinese mitten crab, all tasks are necessary (inseparable). Although each set of tasks associated with an objective provides different information, none of the tasks by itself provides sufficient information to develop such a management strategy.

Technical Feasibility

Larval settlement: We do not anticipate any problems with these tasks. We will use well-established and widely used techniques to assess larval settlement. Further, detailed keys are readily available for identifying crab larvae, including the Chinese mitten crab (Poole 1966; Newell and Newell 1977; Kim & Hwang 1995).

Reproductive events: We do not anticipate any problems with these tasks. Trawling operations will be conducted under the auspices of the Marine Science Institute of Redwood City (non-profit educational organization). This organization conducts trawl surveys in SFB as part of their educational program. We will also obtain crabs from the California Department of Fish & Game, who conduct monthly trawls in SFB.

Size ut maturity: We do not anticipate any constraints with completion of this task, especially given our experience with maintaining mitten crabs in the laboratory. We will use traditional techniques to assess age at maturity, and minimize holding time in the laboratory. We have the appropriate permits and facilities for transporting and holding mitten crabs at U.C. Santa Barbara, and are currently doing so for a Sea Grant funded project (see section Qualifications). Further, we will obtain juvenile mitten crabs from other mitten crab researchers working on this stage (which we are currently doing), eliminating the need for additional permits.

APPLICABILITY TO CALFED ERP GOALS

This project targets ERP Goal 5, the reduction of negative biological and economic impacts of an established non-native invasive species. We seek basic life history information on the Chinese mitten crab, ***Eriocheir sinensis,*** particularly regarding adult reproduction and larval settlement, in order to develop an effective and efficient theoretically-based removal strategy. Development and subsequent implementation of a well-defined management strategy will help reduce/eliminate negative impacts associated with *this* pest (NIS Goal III). At a minimum, impacts to fish recovery operations and commercial and recreational fisheries will be reduced, as well as anticipated ecological impacts to California species through predation, competition and habitat destruction (due to burrowing activities) by the mitten crab. Further, in accordance with NIS Goal II, development and implementation of management efforts will limit the spread of the mitten crab not just within SFB and associated watersheds, but also to other North American habitats.

Importantly, there are several reasons why management strategies need to be developed for the SFB Chinese mitten crab. First, economic impacts to several different groups (water diversion plants, commercial fishermen, power plants, recreational fishermen) have already occurred and will continue until the crab population is substantially reduced/eliminated. Second, although major ecological impacts remain largely undocumented (but are the focus of several current studies), many impacts are anticipated as it occupies freshwater habitats that have ***never*** supported such an organism. Thus, not only will California species likely be more susceptible to predation by the mitten crab (i.e., they likely lack evolved defenses against it), but they would also likely be unable to naturally control the mitten crab population through predation (it is an unfamiliar prey item). In fact, although California predators of the mitten crab exist, they are currently ineffective at controlling the mitten crab population as evidenced by the high abundance of crabs in SFB. The anticipation of substantial impacts to California species and habitats, and the need for management efforts, are both supported by the introduction of the Chinese mitten crab into Germany which resulted in substantial ecological impacts, including extinction of at least one species and declines of several other organisms (finfish and shellfish). **As** in our case, the mitten crab was **a** unique addition to their freshwater ecosystems. This is unlike many other non-native invasive species that are often introduced into areas containing similar organisms. Third, further spread of this non-native invasive species, not only within the SFB area but also to other North American watersheds, is likely given the current abundance of the **SFB** mitten crab population. The persistence of the SFB population greatly increases the chance of introduction into other regions through domestic transport via ballast water. Further, unlike most other NIS, this pest is a highly valued food item (up to $30 per gravid female crab). This high market value substantially increases the potential spread of this species by intentional introduction and/or transport through live-food black markets. Potentially, larval dispersal may also lead to the spread of this species. Although the mechanism responsible for the spread of the Chinese mitten crab in Europe is unknown, this pest now has an enormous distribution, spreading from Germany into Poland, Russia and Czechoslovakia, down through the Netherlands, Belgium, and France and recently into Spain and Portugal. Without development and subsequent implementation of management measures in California, the SFB population could provide a source for establishment elsewhere in California and/or the nation.

Lastly, and perhaps most importantly, the mitten crab has some biological features that may make it vulnerable to management efforts. For example, SFB mitten crabs presumably live for only 2-3 years and apparently contribute reproductively for only one season before dying (Veldhuizen and Hieb 1998). Thus, recruitment is dependent on larval production of a single year class, with the population potentially consisting of only two or three year classes. This short life expectancy and limited reproductive contribution suggests that the population is likely vulnerable to management efforts targeting reproductive events, and that management efforts may only be needed for a relatively short time. Furthermore, the Chinese mitten crab is catadromous, and thus a particularly unique crustacean with specific behaviors and physical tolerances associated with each life cycle stage. Some of these behaviors/tolerances may provide

vulnerabilities that could be exploited. For example, mitten crabs that have undergone their molt of puberty must migrate to brackish waters to breed. Such migrations reduce the spatial distribution of the crabs, as they migrate from extensive freshwater tributaries to SFB. Manipulation of adult crabs at bottlenecks where they enter the bay or brooding grounds once in the bay would likely substantially reduce larval production, and thus recruitment and the mitten crab population.

This project is closely related to several ongoing studies of the Chinese mitten crab (Table 1). Although none of these ongoing projects are directly designed for development of management strategies, as is ours, several will provide useful information on potential removal techniques. This information will be integrated into the development of our removal-based management strategy.

More broadly, this project will complement projects dealing with habitat restoration and ecosystem health by providing information needed to manage the Chinese mitten crab. Management of this species will reduce potential impacts to levees and restored habitats by reducing/eliminating habitat destruction due to the burrowing activities of the mitten crab. Further, ecosystem health will be improved as anticipated ecological impacts, including direct impacts to native species through predation, competition and habitat destruction (due to burrowing activities) by the mitten crab, are reduced/eliminated through management.

Table 1. Related studies on the Chinese mitten crab

Project Title	Funding Source	Organization
An evaluation of the impacts of the Chinese mitten crab on the benthic community in the Sacramento-San Joaquin Delta **and** Suisun Bay	CALFED 2000	Dept. of Water Resources
Assessing the distribution and population dynamics of the Chinese mitten crab in the San Francisco Bay and its southern tributaries.	CALFED 2000	Univ. of California, Berkeley
Assessment of the habitat use of the Chinese mitten crab in freshwater habitats of the San Joaquin River Basin.	IEP 2000	US Geological Survey
Habitat use of the Chinese mitten crab in the Sacramento-San Joaquin Delta.	IEP 1999 & 2000	Dept. of Water Resources

QUALIFICATIONS

Dr. Carrie Culver (U.C. Santa Barbara) will function as the Lead Principal Investigator for the project. She will be responsible for technical training, data analysis, report/article writing and program management (including scientific presentations/manuscripts). She has extensive experience in both introduced species and crustacean biology. **As** part of her Ph.D. research, she designed and conducted the first apparently successful eradication program for a non-native *marine* pest (accepted for publication in *Biological Invasions).* She has also conducted extensive laboratory and field research on crustaceans, particularly on growth and management ***of*** the California spider crab, *Loxorhynchus grandis* (published in Master's thesis, the Journal of Shellfisheries Research and in California Living Marine Resources). She is currently involved in a Sea Grant funded project looking at mitten crab parasites. Through this project she has gained experience in maintaining mitten crabs in the laboratory. In addition, she has begun preliminary assessments of growth and larval settlement and participated in the MSI/Redwood City annual

mitten crab survey. She has also served; and continues to serve, on the IEP mitten crab work team.

Dr. Mark Walter (U.C. Santa Barbara) will function as co-principal investigator, being responsible for day-to-day operation and supervision. He will also assist with report/article writing and program management. Dr. Walter is currently lead researcher on the mitten crab parasite project, collaborating with Dr. Culver. As such, he has extensive experience in working with this species and has participated in the preliminary studies and surveys mentioned above. He also serves on the IEP mitten crab work team. He is familiar with relevant lab and field work required for this project. In particular, he assisted Dr. Culver with the eradication efforts mentioned above and has conducted independent laboratory research using a freshwater system.

Tanya Veldhuizen (California Department of Water Resources) will function a collaborator from DWR. She will provide technical field expertise to the project, including identifying *exact* locations for deployment of larval collectors (so as to avoid potential vandalism and/or boat traffic), assisting with trawling operations and providing juvenile crabs for laboratory experiments. She has conducted field research on both native and invasive non-native crabs in the San Francisco Estuary. She conducted the initial monitoring surveys for the Chinese mitten crab in the Delta and Suisun Marsh, and has tracked the mitten crab's spread through the Central Valley drainage system since its introduction. She is currently conducting a field study on the habitat use of the Chinese mitten crab in the Sacramento-San Joaquin Delta, funded by the Interagency Ecological Program (part of her Master's Thesis). She also serves as biological advisor to DWR's Fish Facility Section on the development and evaluation of the mitten crab barrier devices at the State Water Project fish protection facility. Her work is cited throughout this proposal.

COST

The total cost for this project is $229,963 (see Attachments 1 and 2). As many tasks are labor intensive, salaries represent the largest expense for this project. The lead P.I. (Culver @ 50%) will be responsible for technical training, data analysis, report/article writing and program management (including scientific presentations/manuscripts). The co-P.I. (Walter @ 50%) will be responsible for day-to-day operation and supervision. He will also assist with report/article writing and program management. Several undergraduate assistants will be hired to process larval collectors and maintain crabs in the lab. Costs for travel are also substantial because this project requires a large amount of field work, encompassing a large spatial scale. This cost also includes boat time and associated expenses to conduct several trawl surveys. The majority of the supply costs are for the larval collectors. This includes the purchase of 12 temperature loggers (Hobo®) which are needed to record daily temperature fluctuations at the sites. The overhead rate for this off campus project is 26%. This rate includes costs associated with general administrative functions for the grant.

LOCAL INVOLVEMENT

Letters of notification have been sent to both the County Board of Supervisors and the County Planning Departments of Alameda, Santa Clara, San Mateo, Marin, Sonoma, Solano and Contra Costa counties (copies attached). We are currently working with many other local entities, including The Marine Science Institute of Redwood City (non-profit educational environmental organization), the California Department of Fish & Game and the University of California, Berkeley. We have also been in contact with commercial shrimp trawlers, the Don Edwards National Wildlife Refuge, the Palo Alto Baylands Nature Reserve, and the Farallones National Marine Sanctuary who are also supportive of our research efforts. All collaborators on this project are members of the IEP Chinese Mitten Crab Project Work Team. As such, we are in continual contact with parties affected by this non-native invasive species, including state and

federal water diversion facilities. These facilities are particularly supportive of this project as it may provide a means for predicting strong year classes, and thus years of heavy impact.

There are no apparent third party impacts associated with this project.

COMPLIANCE WITH STANDARD TERMS AND CONDITIONS

Please see institutional cover letter accompanying this proposal for exception taken to State and Federal standard terms.

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Figure 1. Conceptual Model.

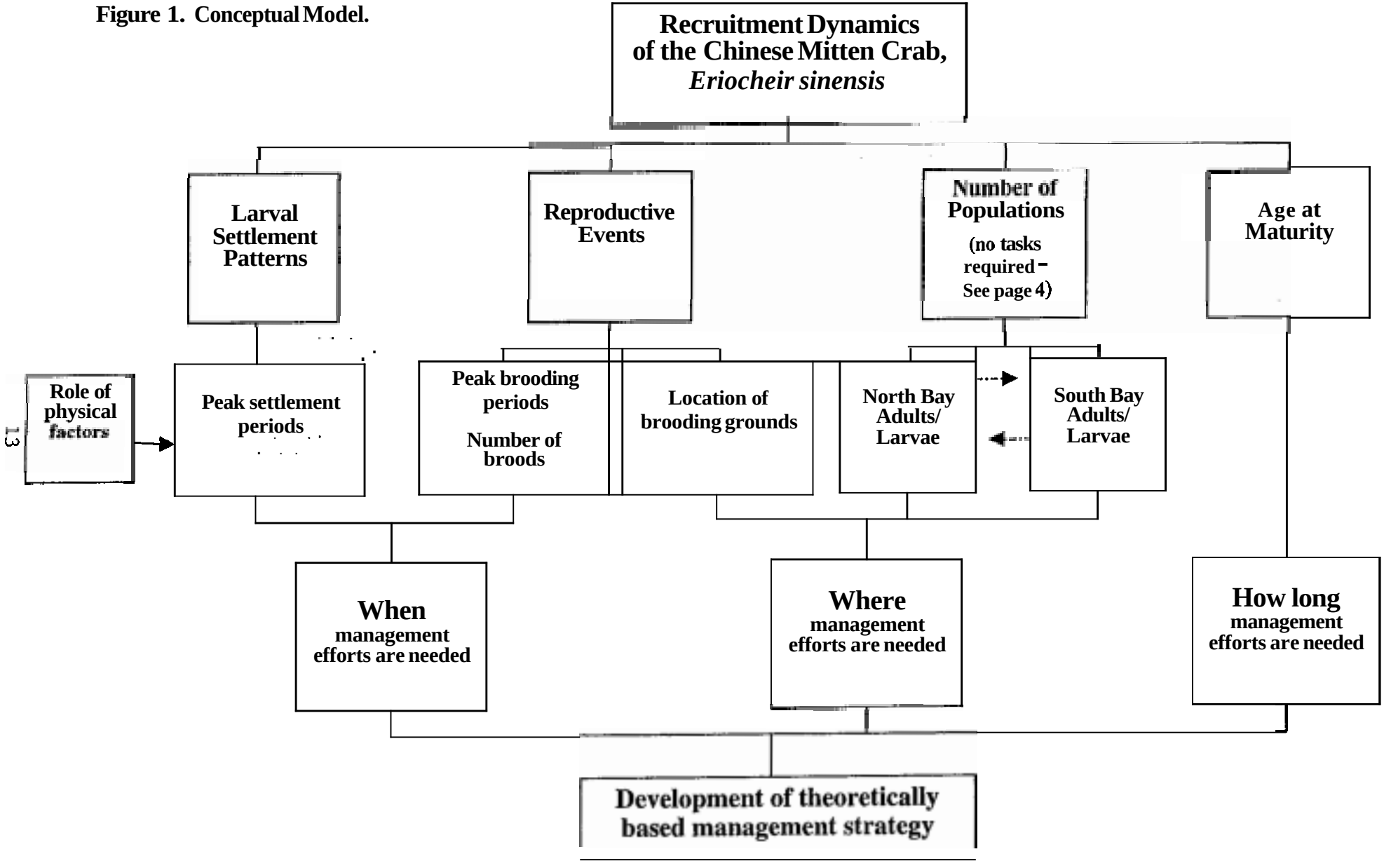
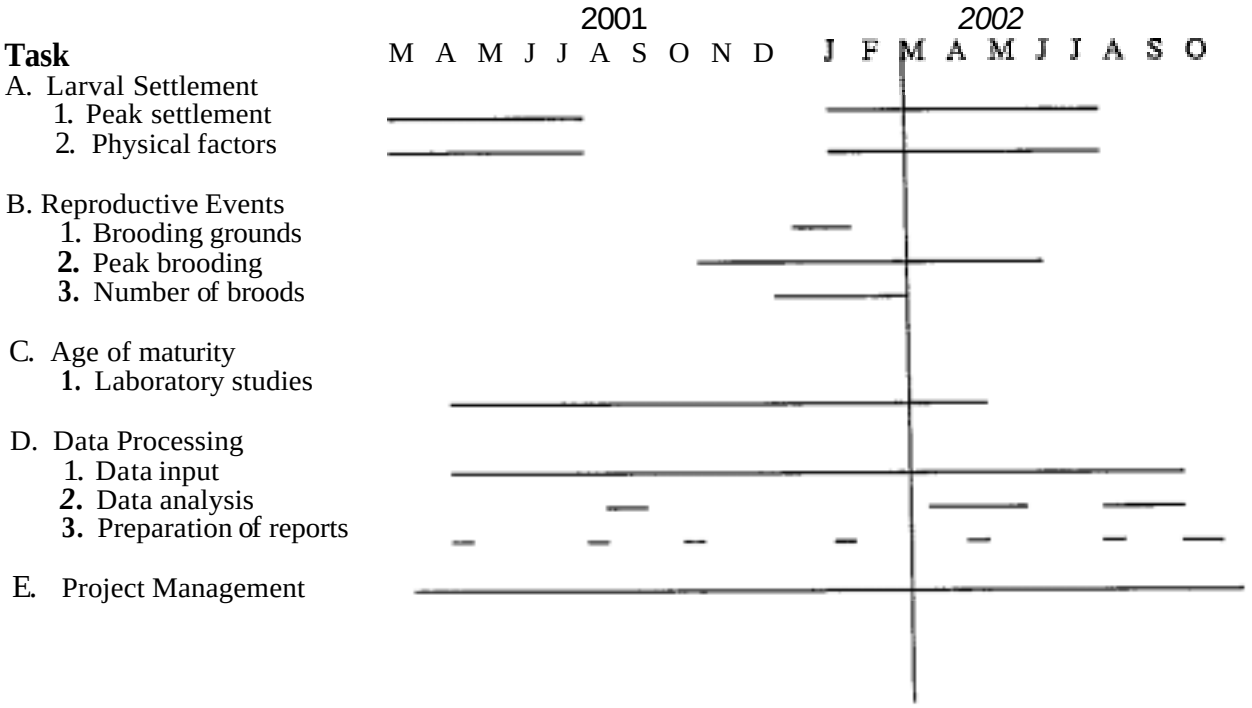


Figure 2. Milestone Chart



ATTACHMENT 1

DETAILED BUDGET

SALARIES	Period/mos.	% Time	First Period 3/1/01- 2/28/02	Second Period 3/1/02- 10/31/02
1. Co-Principal Investigator - Culver				
Assistant Research Biologist				
@ 54,051 *Irno.* 1st per.	7	50%	$ 14,179	
@ $4,214 *Irno.* 1st per.	5	50%	10,535	
@ 54,214 *Irno.* 2nd per.	4	50%		$ 8,428
@ $4,664 *Imo.* 2nd per.	3	50%		6,996
@ $4,842 *Irno.* 2nd per.	1	50%		2,421
2. Co-Principal Investigator - Walter				
Assistant Research Biologist				
@ $4,051 /mo. 1st per.	7	50%	14,179	
@ $4,214 *Irno.* 1st per.	5	50%	10,535	
@ $4,214 /mo. 2nd per.	4	50%		8,428
@ $4.664 *Irno.* 2nd per.	3	50%		6,996
@ $4,842 *Irno.* 2nd per.	1	50%		2,421
3. Laboratory Assistant I - To be named				
2 @ $10.20 /hr. 1st per. (96 hrs./ea.)	4	var.	1,958	
2 @ $10.40 /hr. 1st per. (72 hrs./ea.)	3	var.	1,498	
2 @ $10.40 Ihr. 2nd per. (72 hrs./ea.)	3	var.		1,498
2 @ $10.61 /hr. 2nd per. (48 hrs./ea.)	2	var.		1,019
4. Assistant II - Undergraduate Student				
2 @ $7.00 /hr. 1st per. (1,198 hrs./ea.)	12	var.	16,772	
2 @ $7.25 Ihr. 2nd per. (665 hrs./ea.)	12	var.		9,643
Salaries Subtotal			5 69,656	5 47,850

FRINGE BENEFITS

1. Co-Principal Investigator - Culver			
Basesum: 524,714 @ 17.0% 1st per.	$ 4,201		
$17,845 @ 17.0% 2nd per.		5	3,034
2. Co-Principal Investigator - Walter			
Basesurn: $24,714 @ 17.0% 1st per.	4,201		
517,845 @ 17.0% 2nd per.			3,034
3. Laboratory Assistant I			
Base sum: $3,456 @ 4.3% 1st per.	149		
$2,517 @ 4.3% 2nd per.			108
4. Assistant II			
Base **sum:** 516,772 @ 4.3% 1st per.	721		
$9,643 @ 4.3% 2nd per.			415
Benefits Subtotal	$ 9,272	5	6,591

DETAILED BUDGET (Cont'd)	First Period 3/1/01- 2/28/02	Second Period 3/1/02- 10/31/02
SUPPLIES		
1. Larval collectors (tuffys, line, floats, weights)	$ 3,000	$ 1,000
2. Hobo temperature loggers	1,500	
3. Misc. field and laboratory supplies (calipers, containers, film)	850	
4. Food for crabs	500	50
5. Research-related computer supplies (software, diskettes, toner cartridges, etc.)	850	300
Supplies Subtotal	$ 6,700	$ 1,350
TRAVEL		
1. RT SB-SF Bay/Delta - 24 trips 1st per., 9 trips 2nd per. Private vehicle mileage expense, 800 miles per trip @ $.325/mi.	$ 6,240	$ 2,340
2. RT travel to quarterly IEP meetings - 4 meetings 1st per., 3 mtgs. 2nd per.		
a. Private vehicle mileage, 700 mi./trip @ $.325/mi.	910	683
b. 1 night lodging per trip @ $80/night	320	240
c. 2 days meals per trip @ $46/day	368	276
3. RT travel to annual CALFED conference		
a. Private vehicle mileage, 700 mi. @ $.325/mi.	228	228
b. 3 nights lodgings @ $80/night	240	240
c. 2 days meals per trip @ $46/day	184	184
d. Conference registration	120	120
4. Retrieval of larval collectors from SF Bay - 28 trips 1st per., 20 trips 2nd per.		
a. Private Vehicle mileage: 100/mi./trip @ $.325/mi.	910	650
b. Boat fuel: 40 mi./trip @ $.63/mi.	706	504
Travel Subtotal	$ 10,226	$ 5,465
PUBLICATION COSTS		$ 500
OTHER DIRECT COSTS		
1. Communication costs (telephone tolls, fax, etc.)	$ 500	$ 400
2. Trawling - 12 trawling trips @ $2,000/ea.	24,000	
Other Direct Costs Subtotal	$ 24,500	$ 400
Total Direct Costs	$ 120,354	$ 62,156
INDIRECT COSTS		
Off-campus rate" of Modified Total Direct Costs Basesum: $120,354 @ 26% 1st per.	$ 31,292	
$62,156 @ 26% 2nd per.		$ 16,161
TOTAL COSTS	$ 151,646	$ 78,317
TOTAL COSTS TWENTY MONTHS	$ 229,963	

* This is the DHHS negotiated, predetermined, off-campus rate for Research Projects covering the period July 1, 1997 - June 30, 2000. The rate thereafter is provisional.

(cul#.0061)

ATTACHMENT **2 - Summary Budget**

EAR 1 (March 2001 - February 2002)								
2 months	**Tasks**	**Hours**	**Salary**	**Benefits**	**Travel**	**Supplies**	**Overhead**	**Total Cost**
	1. Larval Settlement	1754	20384	2137	3436	3000	7529	36487
	2. Reproductive Events	1246	17620	2352	25560*	2100	12384	60016
	2a&b. Grounds+ Peak	1162	17032	2326	22560*	2000	11419	55337
	2c. # Broods	84	588	25	0	100	185	899
	3. Age at maturity	641	7974	972	2860	750	3264	15820
	4. Data processing	964	18730	2971	0	600	5798	28099
	4a. Data entry	240	1680	72	0	200	508	2460
	4b. Data analysis	307	7147	1215	0	200	2226	10788
	4c. Reports/articles	417	9903	1684	0	200	3065	14851
	5. Program Mgmt	209	4947	841	2370	750	2316	11224
otal Cost Year 1		4814	69656	9272	34226*	7200	31292	151646
EAR 2 (March 2002 - October 2002)								
months	Task 1 a & b	Hrs	Salary	Benefits	Travel	Supplies	Overhead	Total Cost
	1. Larval Settlement	1164	12976	1228	2454	1000	4590	22245
	2. Reproductive Events	748	11329	1558	1040	0	3621	17547
	2a&b. Grounds+ Peak	748	11329	1558	1040	0	3621	17547
	3. Age at maturity	55	399	17	0	50	121	587
	4. Data processing	856	19447	3159	0	600	6034	29239
	4a. Data entry	160	1160	50	0	0	315	1524
	4b. Data analysis	348	9144	1554	0	100	2807	13605
	4c. Reports/articles	348	9144	1554	0	500	2911	14109
	5. Program Mgmt	1401	37001	6291	1971	6001	17941	8694
'otal Cost **Year 2**		2963	47851	6590	5465	2250	16161	78313
'OTAL PROJECT COST		7777	117504	15863	39691*	9450	47452	229963

Travel costs for Year **1** include **expenses** for 12 trawling surveys (total = $24,000)

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MARINE SCIENCE INSTITUTE
SANTA BARBARA, CALIFORNIA 93106-6150

May 10,2000

Clerk of the Board
Board of Supervisors
651 Pine Street
Martinez, CA 94553

To Whom It May Concern:

Enclosed please find a copy of the Executive Summary for our research proposal entitled: Development of an effective management strategy for the introduced Chinese mitten crab, *Eriocheir sinensis*: Investigations of recruitment dynamics. This research proposal is being submitted to the CALFED Bay-Delta Program. As part of CALFED's Proposal Solicitation Package we are required to notify local government agencies associated with areas where work is proposed. Our activities will include deployment of larval collectors, trawl surveys and laboratory studies. Activities will be primarily based within San Francisco Bay, south of the San Mateo Bridge and North of Pt. Richmond. Larval collections will occur in association with the following freshwater flows: Petaluma River, Suisun Slough, Sacramento/San Joaquin Rivers (Chipps Island) in the North Bay and Alameda Creek, Guadalupe Slough and Permanente Creek in the South Bay. If funded, work would begin in spring/summer 2001.

Please feel free to contact us at (805) 893-8083 if you have any questions.

Sincerely,

Carrie S. Culver, Ph.D.
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Mark Walter, Ph.D.
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MARINE SCIENCE INSTITUTE
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Redwood City, CA **94063**

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Please feel free to contact us at (805) 893-8083 if you have any questions.

Sincerely,

Carrie S. Culver, Ph.D.
c_culver@lifesci.ucsb.edu

Mark Walter, Ph.D.
walter@lifesci.ucsb.edu

enclosure

UNIVERSITY OF CALIFORNIA, SANTA BARBARA

BERKELEY . DAVIS . IRVINE . LOS ANGELES . RIVERSIDE . SAN DIEGO . SAN FRANCISCO **SANTA** BARBARA . SANTA CRUZ

TELEPHONE (805)893-3765
FAX (805)893-8062
EMAIL **admin@msi.ucsb.edu**
WWW http://www.msi.ucsb.edu

MARINE SCIENCE INSTITUTE
SANTA BARBARA, CALIFORNIA **93106-6150**

May 10,2000

Clerk of the Board
Board of Supervisors
2300 County Center Drive
La Plaza Bldg. B 177
Santa Rosa, **CA** 95402

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MARINE SCIENCE INSTITUTE
SANTA BARBARA . CALIFORNIA 93106-6150

May 10,2000

Clerk of the Board
Board of Supervisors
3501 Civic Center Drive
San Rafael, CA 94903

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WWW hrtp:/lwvvi.rnsi.ucsb.edu

MARINE SCIENCE INSTITUTE
SANTA BARBARA, CALIFORNIA 931064150

May 10,2000

Clerk of the Board
Board of Supervisors
County Administration Bldg.
1221 *Oak* Street, Room 536
Oakland. CA 94612

To Whom It May Concern:

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MARINE SCIENCE INSTITUTE
SANTA BARBARA, CALIFORNIA 93106-6150

May 10,2000

Clerk
Planning Department
224 W. Winton Avenue
Hayward, CA 94544

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MARINE SCIENCE INSTITUTE
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Clerk
Planning Department
3501 Civic Center Drive
San Rafael, CA 94903

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M. Walter, Ph.D.
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Planning Department
2550 Ventura Avenue
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May 10,2000

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Planning Department
580 Texas Street
Fairfield, CA 94533

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Planning Department
County Government Center
70 W. Hedding Street
San Jose, CA 95110

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SANTA BARBARA, CALIFORNIA 93106-6150

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Clerk
Planning Department
455 County Center
Redwood City, CA 94063

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MARINE SCIENCE INSTITUTE
SANTA BARBARA. CALIFORNIA 93106-6150

May 10,2000

Clerk
Planning Department
651 Pine Street
Martinez, CA 94553

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Environmental Compliance Checklist

All applicants must fill out this Environmental Compliance Checklist. Applications must contain answers to the following questions to be responsive and to be considered for funding ***Failure to answer these questions and include them with the application will result in the application being considered nonresponsive and not considered for funding.***

1. **Do** any of the actions included in the proposal require compliance with either the California Environmental Quality Act (CEQA), the National Environmental Policy **Act** (NEPA), **or** both?

   ____ **YES** X NO

2. If you answered **yes** to # **1,** identify the lead governmental agency **for** CEQA/NEPA compliance.

   _____
   Lead Agency

3. If you answered **no** to # **1,** explain why CEQA/NEPA compliance is not required for the actions in the proposal.

4. If CEQA/NEPA compliance is required, describe how the project will comply with either **or** both of these laws. Describe where the project is in the compliance prows and the expected date of completion.

5. Will the applicant require access across public **or** private property that the applicant does not **own** to accomplish the activities in the proposal?

   X **YES** **NO**

   If yes, the applicant must **attach** written permission for access from the relevant property owner(s). Failure to include written permission for access may result in disqualification of the proposal during the **review** process. Research and monitoring field projects for which specific field locations have not been identified **will** be **required** to provide access **needs** and permission for access with **30** days of notification of approval.

   All access is along public waterways for which no permission is needed. Specific field locations will be indetified and this information provided to CALFED **within 30 days of notification of approval.**

6. Please indicate what permits **or** other approvals may be required **for** the activities **contained** in your proposal. Check all boxes that apply.

LOCAL

Conditional use permit	___	
Variance	___	
Subdivision Map Act approval	___	
Grading pennit	___	
General plan amendment	___	
Specific plan approval	___	
Rezone	___	
Williamson Act Contract cancellation	___	
Other _____ (please specify)		
None required	___	

CESA Compliance	___	(CDFG)
Streambed alteration permit	___	(CDFG)
CWA § **401** certification	___	(RWQCB)
Coastal development pennit	___	(Coastal Commission/BCDC)
Reclamation Board approval	___	
Notification	X	(DPC, BCDC)
Other CDFG **Scientific Collecting** Permit (please specify)		
None required	___	

FEDERAL

ESA Consultation	___	(USFWS)
Rivers & **Harbors** Act permit	___	(ACOE)
CWA **$404** permit	___	(ACOE)
Other _____ (please specify)		
None required	___	

DPC = Delta Protection Commission
CWA = Clean Water Act
CESA = California Endangered Species Act
USFWS = U.S. Fish and Wildlife Service
ACOE = U.S. Army Corps of Engineers

ESA = Endangered Species Act
CDFG = California Department of Fish and Game
RWQCB = Regional Water Quality Control Board
BCDC= Bay Conservation and Development Comm.

Land Use Checklist

All applicants must fill out this Land Use Checklist for their proposal. Applications must contain answers to the following questions to be responsive and to be considered for funding. ***Failure to answer these questions and include them with the application will result m the application being considered nonresponsive and not considered for funding.***

1. Do the actions in the proposal involve physical changes to the land (i.e. grading, planting vegetation, **or** breeching levees) **or** restrictions in land use (i.e. conservation easement **or** placement of land in a wildlife refuge)?

   _____ YES _____ NO

2. If NO to # **1,** explain what type of actions are involved in the proposal (i.e., research only, planning only).

   Research only

3. If YES to # **1,** what is the proposed land use change **or restriction** under the proposal?

4. If **YES** to # **1,** is the land currently under a Williamson **Act contract?**

   _____ YES _____ NO

5. If YES to # **1,** answer the following:

   Current land use _____
   Current zoning _____
   Current general plan designation _____

6. If **YES** to **#1,** is the land classified **as** Prime Farmland, Farmland of Statewide Importance **or** Unique Farmland on the Department of Conservation Important Farmland Maps?

   _____ YES _____ **NO** _____ DON'T KNOW

7. If YES to # **1,** how many acres of land will be subject to physical change **or** land use restrictions under the proposal?

   _____

8. **If YES to # 1, is** the properly currently being commercially farmed **or** grazed?

   _____ **YES** _____ NO

9. **If YES** to #S. what are the number of employees/acre_____
   the **total** number of employees _____

10. Will the applicant acquire any interest in land under ***the*** proposal (fee **title or** a mnservation easement)?

_____ **YES** X NO

11. What entity/organization **will** hold the interest?_____

12. **If YES** to # 10, answer the following:

Total number **of** acres to be acquired under proposal _____
Number **of** acres to be acquired in fee _____
Number of acres to be **subject** to mnservation easement _____

13. **For all** proposals involving physical changes **to** the land **or** restriction in land **use,** describe what **entity or** organization will:

manage **the** property _____

provide operations and maintenance services _____

conduct monitoring _____

14. **For** land acquisitions (fee **title or** easements), will existing water rights also **be** acquired?

_____ **YES** _____ **NO**

15. **Does the** applicant propose any modifications **to the** water right **or** change in **the** delivery of the water?

_____ **YES** X **NO**

16. If **YES** to # **15,** describe_____

JONDISCRIMINATIONCOMPLIANCE STATEMENT

TD. 19 (REV. 3-95)

COMPANY NAME

The company named above (herinafter referred to as "prospective contractor") hereby certifies, unless specifically exempted, compliance with Government Code Section 12990 (a-f) and California Code of Regulations, Title 2, Division 4, Chapter 5 in matters relating to reporting requirements and the development, implementation and maintenance of a Nondiscrimination Program. Prospective contractor agrees not to unlawfully discriminate, harass or allow harassment against any employee or applicant for employment because of sex, race, color, ancestry, religious creed, national origin, physical disability (including HIV and AIDS), medical condition (cancer), age (over 40), marital status, denial of family care leave and denial of pregnancy disability leave.

CERTIFICATION

I, the official named below, hereby swear that I am duly authorized to legally bind the prospective contractor to the above described certification. I am fully aware that this certification, executed on the date and in the county below, is made under penalty of perjury under the laws of the State of California.

OFFICIAL'S NAME

THE REGENTS OF THE UNIVERSITY OF CALIFORNIA

DATE EXECUTED MAY 12 2008

EXECUTED IN THE COUNTY OF

PROSPECTIVE CONTRACTOR'S SIGNATURE

ORIGINAL SIGNED BY MICHIKO TANIGUCHI

PROSPECTIVE CONTRACTOR'S TITLE

PROSPECTIVE CONTRACTOR'S LEGAL BUSINESS NAME

Standard Form 424

OMB Approval NO. 0348-0043

APPLICATION FOR FEDERAL ASSISTANCE

1. TYPE OF SUBMISSION: Application / Preapplication	2. DATE SUBMITTED	Applicant identifier
☐ Construction / ☐ Construction	a. DATE RECEIVED BY STATE	State Application Identifier
☒ Non-Construction / ☐ Non-Construction	4. DATE RECEIVED BY FEDERAL AGENCY	Federal Identifier

5. APPLICANT INFORMATION

Legal Name: The Regents of the University of California	Organizational Unit: Office of Research
Address (give city, county, state, and zip code): University of California, Santa Barbara, CA 93106-2050	Name and telephone number of the person to be contacted on matters involving this application (give area code): Carolynn Culver (805) 893-8083
6. EMPLOYER IDENTIFICATION NUMBER (EIN): 95-6006145	7. TYPE OF APPLICANT (enter appropriate letter in box): I

A. State
B. county
C. Municipal
D. Township
E. Interstate
F. Intermunicipal
G. Special District
H. Independent
I. slate Controlled institution of Higher Learning
J. Private University
K. Indian Tribe
L. Individual
M. Profit Organization
N. Other (Specify):

8. TYPE OF APPLICATION:
☐ New ☐ Continuation ☐ Revision

If revision, enter appropriate letter(s) in box(es): ☐ ☐

A. Increase Award B. Decrease Award C. increase Duration
D. Decrease Duration Other (Specify):

9. NAME OF FEDERAL AGENCY: CALFED, Department of the Interior

10. CATALOG OF FEDERAL DOMESTIC ASSISTANCE NUMBER: ☐☐ - ☐☐
TITLE:

11. DESCRIPTIVE TITLE OF APPLICANT'S PROJECT: Development of an Effective Management Strategy for The Introduced Chinese Mitten Crab, *Eriocheir* sinensis: Investigations of Recruitment Dynamics

12. AREAS AFFECTED BY PROJECT (cities. counties. states, etc.): Solano, Sonoma, Marin, Santa Clara, Contra Costa, Alameda, San Mateo

13. PROPOSED PROJECT:

Stan Date	Ending Date
March 1,2001	October 31,2002

14. CONGRESSIONAL DISTRICTS OF:

a. Applicant	b. Project
22nd	6, 7, 8, 9, 12, 13, 14

15. ESTIMATED FUNDING:

a Federal	$ 229,963.00
b. Applicant	$ .00
c. State	$ .00
d. Local	$ .00
e. Other	$ .00
f. Program Income	$ .00
g. TOTAL	$ 229,963.00

16. IS APPLICATION SUBJECT TO REVIEW BY STATE EXECUTIVE ORDER 12372 PROCESS?

a. YES. THIS PREAPPLICATION/APPLICATION WAS MADE AVAILABLE TO THE STATE EXECUTIVE ORDER 12372 PROCESS FOR REVIEW ON: DATE

b. NO ☐ PROGRAM IS NOT COVERED BY E.O. 12372
☐ PROGRAM HAS NOT BEEN SELECTED BY STATE FOR REVIEW

17. IS THE APPLICANT DELINQUENT ON ANY FEDERAL DEBT?
☐ Yes If "Yes," attach an explanation. ☒ No

18. TO THE BEST OF MY KNOWLEDGE AND BELIEF, ALL DATA IN THIS APPLICATION/PREAPPLICATION ARE TRUE AND CORRECT. THE DOCUMENT HAS BEEN DULY AUTHORIZED BY THE GOVERNING BODY OF THE APPLICANT AND THE APPLICANT WILL COMPLY WITH THE ATTACHED ASSURANCES IF THE ASSISTANCE IS AWARDED.

a. Typed Name of Authorized Representative	b. Title	c. Telephone Number
Michiko Taniguchi	Sponsored Projects Officer	(805) 893-8809

d. Signature of Authorized Representative: Original signed by Michiko Taniguchi

e. Date Signed: MAY 12 2000

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Standard Form 424 (REV 7-97)
Prescribed by OMB Circular A-102